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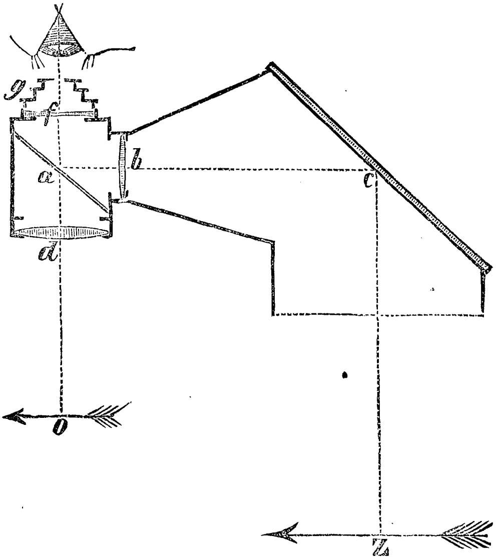
MICROSCOPY.[1]

THOMA'S CAMERA LUCIDA.[2]—The cameras now in use are not well adapted for a low magnifying power (1–6), nor is any allowance made in their construction for the refractive index of the eye. In order to obtain sharp images one is often obliged to bring the drawing-paper nearer the eye, thus materially reducing the field of vision.

In the construction of Thoma's camera the above difficulties are avoided, and it is specially recommended for drawing with a magnifying power of from 1–10 times, and for the production of *reduced drawings.*



1.

The camera consists of a blackened, metallic frame containing two mirrors, one of which, fig. 1,*a,* is an unsilvered glass plate from 0.15 to 0.20 mm. in thickness, while the other (*c*) is a plain silvered mirror. Both mirrors are parallel with each other and inclined at an angle of 45° to the horizon.

In order to draw an object magnified four times, we place at *o* a convex eye-glass with a focal distance of 40 cm., and then fasten the camera upon the vertical rod so that the distance *b c* and *c z* = 40 cm. As the distance *b c* is constant, 10 cm., *c z* must be 30 cm., and may be easily found on the ruled rod that supports the camera.

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[1] Edited by C. O. Whittman, Director of the Lake Laboratory, Milwaukee.

[2] Zeitschrift f. wiss. Mikroskopie, v. 3, p. 297, Sept., 1887.

Next a convex eye-glass of 10 cm. focal distance is inserted at *d*, and the upper end of the sliding ring to which the stage is attached brought within 10 cm. of the lower edge of the ring to which the camera is fastened.

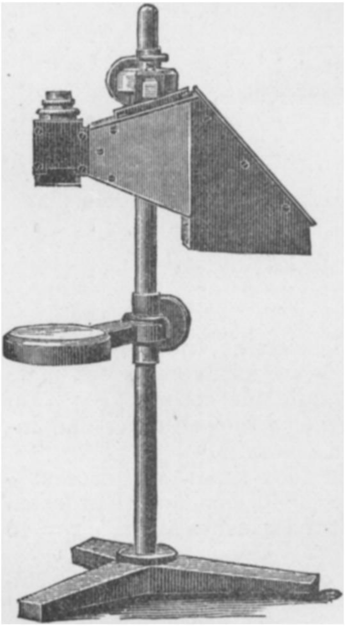
The amount of light is regulated by means of smoked glasses inserted above the convex glass at *d*.

If the eye of the observer is myopic. it is necessary to insert at *f* an eye-glass for correction. A myopic person will often find it convenient to use a glass a little stronger than is required in looking at distant objects.

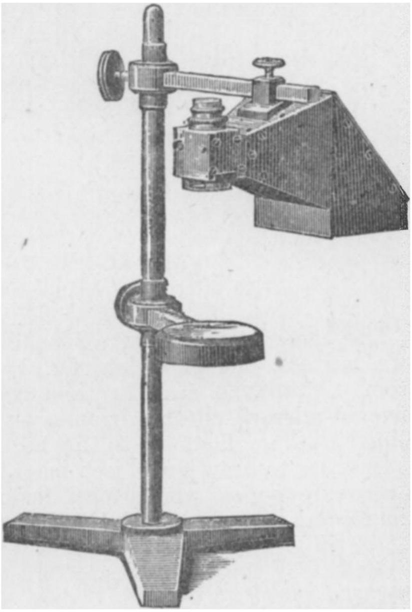
Finally, in all cases, except where a magnifying power of from 1 to 2 times is used, a diopter (*g*) must be placed above *f*. In using the high magnifying powers the focal points of both systems do not exactly coincide, so that a parallactic displacement of the images is produced, if the diopter is left out. This is a defect of all cameras and is usually corrected by the use of small prisms, while here the same object is equally well, and at the same time more conveniently, accomplished by the diopter.

The magnifying power is equal to the ratios of the distances. *b c z* and *d* = 40 : 10 = 4 : 1.

In using the camera, it must stand before the observer, as in fig. 2, with the drawing on the right and the diopter and object on the left.

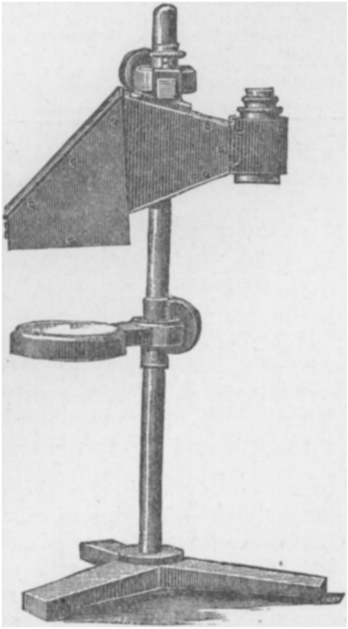


2.



3.

Only in using a magnifying power of from 1–1½ times is the position of the camera reversed, the drawing and object maintaining the same position as before (fig. 4). In this way we look directly at the drawing, while the object is seen through the two mirrors.



4.

For other powers than that given above, the following table may be used:

MAGNIFICATION TABLE.

I.

Diopter and object on the left, drawing and silvered mirror on the right, as in fig. 2.

Diopters of the convex lens necessary at *d* in fig. 1.	Smoked glass, No.	Distance of the object from the convex lens *d*.	Magnification	Diopters of the convex lens necessary at *b* in fig. 1.	Smoked glass, No.	Distance of the drawing paper from the convex lens *b*.
+ 15 = 10 + 5	c	66 mm.	6	+ 2.5	—	400 mm.
+ 12.5 = 12 + 0.5	c	80	5	+ 2.5	—	400 "
+ 10	c	100	4	+ 2.5	—	400 "
+ 10.5 = 10 + 0.5	c	95	3½	+ 3	—	333 "
+ 7.5	d	133	3	+ 2.5	—	400 "
+ 6.25 = 6 + 0.25	d	160	2½	+ 2.5	—	400 "
+ 5	d	200	2	+ 2.5	—	400 "

II.

Object and silver mirror on the left, diopter and drawing on the right, as required for a magnification of 1–1½ times, as in fig. 4.

Diopters of the convex lenses necessary at *b* in fig. 1.	Smoked glass, No.	Distance of the object from convex lens *b*.	Magnification	Diopters of the convex lens necessary at *d* in fig. 1.	Smoked glass, No.	Distance of the drawing paper from the convex lens *b*.
+ 5	—	200 mm.	1½	3.25=3+0.25	d	300 mm.
+ 4	—	250 "	1	+ 4=3+1	c	250 "

When in use the whole apparatus is placed upon the drawing-paper, which serves as the source of transmitted light, but reflected light may be used equally well.

One advantage of this camera is that, even with low powers, the field of vision is very large, so that objects from 6–10 cm. in diameter may be drawn. By placing the object in the place of the drawing, and the drawing in place of the object (using the above table), one can reduce the magnification from 1–⅙.

While it is easy by means of the concave glasses to accommodate any eye to the instrument, the apparatus is also a safe and convenient help in laboratories, even to the unexperienced. But as in all such instruments it is better to draw a ruler at the same time with the object.

If one who is able to see clearly with the above combination by inserting at *f* a concave glass of —5 diopters, then, since the distance of this glass from the convex lenses is 3.8 cm., the concave lens may be omitted and the convex lenses at *b* and *d* replaced by others, 6.25 diopters smaller. With a concave glass of + 5 D. at *f*, it is possible to obtain a magnifying power of 8 times by inserting at *d*, 50 cm. from the object, a convex glass of + 20 D., and at *b*, a convex glass of + 2.5 D., 400 mm. above the drawing-paper. If the concave at *f* is omitted, then, leaving object and lens in same position as before, it will be sufficent to place at *d* a convex glass of + 20 — 6.25=13.75 diopters, and at *b* one of + 2.5 — 6.25= — 3.75 Ds. One may thus obtain an 8-fold power without using too strong glasses. For eyes of a different refractive index, the number of diopters to be deducted changes.

If in the previous combination it is necessary to have at *f* a concave glass of — 1 D., this may be removed by deducting 1 D. from the glasses at *d* and *b*.

In the same way,

A concave glass of — 2 D's at *f*, may be replaced by — 2.16 D's at *d* and *b*.
" " — 3 " " " — 3.40 " "
" " — 4 " " " — 4,72 " "
" " — 5 " " " — 6.17 " "
" " — 6 " " " — 7.75 " "
" " — 7 " " " — 9.52 " "
" " — 8 " " " —11.50 " "

If in the first named combination a concave glass of — 2 D. is necessary at *f*, a myopic condition of — 8 D. may be produced if a convex glass of + 6 D's is placed in front of the one at *f*.

In the same way:

For an eye of — 3 D's—we must add + 5 D.
" " — 4 " " " + 4 "
" " — 5 " " " + 3 "
" " — 6 " " " + 2 "
" " — 7 " " " + 1 "
" " — 8 " " " 0 "
" " — 9 " " " — 1 "
" " —10 " " " — 2 "

in order to produce a myopic condition of — 8 D's. When this condition is produced, we may obtain higher magnifying powers, as follows:

III.

Diopter and object on the left, drawing and silver mirror on the right, as in figure 2.

Diopters of the convex lens at *d*.	Smoked glass, No.	Distance of the object from the convex lens *d*.	Magnification.	Diopters of the concave lenses at *b*.	Distance of the drawing paper from the convex lens *b*.
+7	d	57 mn.	7	—9	400 mm.
+8.5 =7.5+1	d	50	8	—9	400 "
+11 = 6+5	c	44	9	—9	400 "
+13.5 =7.5+6	c	40	10	—9	400 "

These combinations produce perfect images, except when the strongest magnifying power is used, when a slight distortion is visible on the edge of the field of vision.

The above described camera, together with a case of 25 glasses, may be obtained of R. Jung, Mechanic and Optician, in Heidelberg, for 120 marks.